Biological Opinion and Letter of Concurrence for Effects to Bald Eagles, Marbled Murrelets, Northern Spotted Owls, Bull Trout, and Designated Critical Habitat for Marbled Murrelets and Northern Spotted Owls from Olympic National Forest Program of Activities for August 5, 2003, to December 31, 2008

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Appendix 1. Estimates of distances at which incidental take of murrelets and spotted owls due to harassment are anticipated from sound-generating, forest-management activities in Olympic National Forest

Introduction

The Marbled Murrelet Recovery Plan (USDI 1997:103) stated that harassment distances for murrelets may be modified from 1/4 mile for most activities and 1 mile for explosives "if: (1) site-specific conditions warrant it; (2) if future research suggests that marbled murrelets are relatively tolerant of human activities, or (3) if experimentation or literature review reveal that noises are attenuated to ambient levels in shorter distances." In this programmatic Biological Opinion and this Appendix, we are complying with all three of these conditions: (1) we allow for site-specific modification of harassment distances for projects; (2) research completed subsequent to the Recovery Plan suggests that murrelets are tolerant of human activities (see below); and (3) we are concerned with the distances at which sound results in injury to murrelets, not the distances at which noises attenuate to ambient levels, so this attenuation to ambient levels is not applicable.

Scope of This Analysis

This analysis presents our thought-process for estimating the distances at which we anticipate incidental take of murrelets and spotted owls due to harassment from sound-generating, forest-management activities in Olympic National Forest (ONF). This analysis does not address anticipated incidental take due to smoke, or harm due to direct or indirect effects. If, for example, it is determined for a project that trees to be felled are likely to either contain nesting murrelets or spotted owls or physically hit a murrelet or a spotted owl, then additional analyses would be required to address those direct effects due to harm. Also, if the likelihood that murrelets would be killed by predators such as corvids would be increased due to these activities, then those indirect effects due to harm would be analyzed separately from this analysis. This analysis also does not address anticipated effects due to the duration of sound-generating activities; these effects should be addressed in the Effects of the Action analyses in individual Biological Opinions.

Factors That Affect Sound

For activities that could disturb murrelets or spotted owls, the proximity of the sights and loudness of a sound are affected by many factors: the ambient and background noise levels present, the equipment used, topography, atmospheric conditions, vegetation, rate of onset, and proximity. Following is a very brief description of these factors, and how we used these factors in the following presentation of the analysis of effects on murrelets and spotted owls.

Ambient and Background Noise and Visual Levels

Ambient levels of sights and sounds here are considered to be sights and sounds from natural causes only—from wind, rain, thunder, a river, or other animals. Background levels of sights and sounds here are considered to be sights and sounds that are generated by people, including vehicles, generators, and traffic sounds. These can vary seasonally as weather, water levels, and traffic patterns change. In the following presentation, we used a general ambient sound level for the Olympic National Forest as the place from which to determine the sound-only detectability threshold.

Types of Equipment Used

For this analysis, we grouped man-caused noises into the following categories: aircraft (helicopter, fixed-winged airplane); blasting; high-impact concussive equipment (impact pile drivers, jackhammers); heavy equipment; and chainsaws. In the following presentation, we determined sound-only injury thresholds for each of these sound-source categories.

Topography

Topography affects whether visual cues can be seen at a distance and how well sound carries. Sound carries farther over flat ground, or from a high point of ground. A ridge can serve as a buffer to noise and visual disturbance, whereas a canyon can contain and amplify noise disturbance. Topography can be used in site-specific cases to analyze effects due to noise, but cannot be used effectively in this programmatic consultation; consequently, we assumed that areas would be flat. If site-specific analyses warrant, topographic features can be used to modify harassment distances as presented here.

Atmospheric Conditions

Temperature and humidity affect how well sounds travel. For example, the tests the U.S. Army conducts of bombs and other loud sound-producing devices in its bases near human populations often are timed when atmospheric conditions "dampen" these sounds (Delaney, US Army COE, pers. comm.). High humidity transmits sounds better than low humidity. Due to the unpredictability of atmospheric conditions, we did not use that factor in the following presentation.

Vegetation

Sounds and sights do not carry as far through vegetation as they do over hard-packed ground or water. All of the activities covered in this programmatic consultation are expected to be conducted in vegetated—usually forested—settings, so we assumed that all areas would be vegetated. We ran the chainsaw sound tests on July 3, 2003, on a "hard site" (on asphalt).

Rate of Onset

There is some evidence (as presented below) that a noise or visual disturbance that starts low and builds, such as a vehicle driving down a road or a helicopter flying from a distance, may result in less risks than a sharp blast, an intense noise, or a sudden movement, such as a rifle shot or a blast during quarry operations. We do not have sufficient information to quantitatively estimate these effects, therefore we did not include these in this presentation.

Proximity

The proximity of a disturbance affects disturbance behavior. Delaney et al. (1999:72) stated that "Distance was a better predictor of spotted owl response to helicopter flights than noise levels." In the following presentation, actual proximity or "apparent proximity" (the apparent closeness of the threat) were the main concerns used to estimate the injury thresholds.

Stress as Evidenced by Increased Levels of Corticosterone

It is possible that murrelets and spotted owls may not visibly react to a disturbance but, nonetheless, produce increased levels of corticosterone in reaction to the disturbance. Corticosterone is released by the hypothalamo-pituitary-adrenal gland to help animals respond to environmental stress. Chronic high levels of corticosterone may have negative effects on reproduction or physical condition (Marra and Holberton 1998). Male spotted owls whose home-range centers were in 0.41 km of a major logging road or recent (within 10 years) timber activity showed higher levels of corticosterone than those with home-range centers farther from logging roads or recent timber activity; females showed no such increase in hormone levels (Wasser et al. 1997). Delaney et al. (1999:67) reported that: "All flushes recorded during the nesting season occurred after fledging; no flushes were elicited by manipulations during the incubation and nestling phases" but 30 percent of spotted owls did flush from branches during the fledging period when the person and operating chainsaw were within 60 meters of the owls. This may indicate that these spotted owls were suppressing their desire to flush during the early nesting season, and that the later-season flush-distance of 60 meters is the distance at which they would become stressed due to chainsaw work.

Black-legged kittiwakes (*Rissa tridactyla*) injected with corticosterone spent nearly 20 times more time away from their nests and less time brooding and guarding their chicks than placebo-implanted birds; however, researchers on that project could not show an effect of corticosterone levels on breeding success (Kitaysky et al. 2001). Nestling mockingbirds (*Mimus polyglottos*) less than 10 days old showed little or no secretion of corticosterone, but late-stage nestlings showed elevated levels when they were to fledge, indicating that young-stage nestlings may not be susceptible to corticosterone effects due to disturbance (Sims and Holberton 2000); it could also be that corticosterone is naturally produced to help in the fledging process.

It is assumed that natural selection would favor incubating adult murrelets and nestling murrelets which were able to stay motionless or nearly motionless so that predators would be less apt to locate them. Consequently, adult murrelets and older nestling murrelets may suffer from increased levels of corticosterone from disturbances but be reluctant to move or, for the adults, flush from the nest. However, we do not know this to be the case. The Marbled Murrelet Technical Group (USDI 2003:28), organized through the FWS Office of Technical Support in Portland, who, in their analysis of effects of sound and visual harassment of murrelets "decided not to include the possible effects of elevated corticosterone... given the lack of data for any avian species showing a clear correlation between elevated corticosterone levels and effects to feeding, breeding or sheltering." In the following presentation, we agreed with them and did not include possible effects of elevated corticosterone.

Summary of Best-Available Information Concerning Disturbance of Birds Other than Murrelets and Spotted Owls

Appendix D of the May 2002 programmatic BO for projects to be conducted in ONF (USDI 2002) presented a summary of the best-available information concerning disturbance of birds other than murrelets and spotted owls but somewhat similar to them. This summary included publications concerning human disturbance of June 25, 2003, birds of the Charadriiformes (alcids, shorebirds, gulls, terns), Gaviiformes (loons), Procellariiformes (albatrosses, petrels), Anseriformes (waterfowl), Falconiformes (hawks, eagles), and Strigiformes (owls) which are on file at the Western Washington Fish and Wildlife Office (WWFWO).

Summary of Best-Available Information Concerning Disturbance of Murrelets

How noises and human presence disturb nesting murrelets are not well known. To date, there have been no tests of the visual or decibel (dB) levels or distances from sounds and/or visual stimuli at which murrelets react or flush from the nest, or the effect of such disturbance on productivity. Typically, we have positive data (instances of reactions) but no negative data (number of times an action was done near a nesting murrelet with no reaction by the murrelet).

Virtually all of the available information concerning disturbance of murrelets is obtained from observations of murrelets incidental to other surveys and research. Long and Ralph (1998:21), in their summary of all available information concerning disturbance of murrelets, reported that "[Marbled] Murrelets appeared generally undisturbed by passing vehicles, or sharp or prolonged loud noise" and "Overall, it appears that Marbled Murrelets are not easily disrupted from nesting attempts by human disturbance except when confronted at or very near the nest itself."

<u>Disturbances to Murrelets Due to Researchers</u>

"Most...impacts were due to the more intrusive influence of investigators...People in the nest tree and especially at the nest cup caused some of the greatest disruptions...Murrelets did not appear to be disturbed by other, less intrusive human activities" (Long and Ralph 1998:20). Researchers approaching within a few meters of the nest caused delayed or aborted attempts to deliver food to young, and caused chicks to defend themselves with open beaks (Hamer and Nelson 1998, Long and Ralph 1998). However, adults also successfully delivered fish to young while Hamer (pers. comm. in Long and Ralph 1998) was 3 meters from the adult in the nest tree but out of view from the adult.

In 1997, a nest was found at the Ruby Beach site on the Olympic Peninsula in which the nest tree was located 8 meters from Hwy 101 (Hamer and Nelson 1998). People walking within 40 meters of the nest in clear view of the nest caused the adults to abort nest visits or flush from the nest 27 percent of the time (n = 30). (Hamer and Nelson 1998:9 states "40 in" in two places, but it should be "40 m" per T. Hamer, Aug 1, 2003, pers. comm.) The length of time the adults stayed on the nest with their chicks when disturbances were present (mean = 11.3 min., SD = 6.8 min., n = 16) vs. when no disturbances were present (mean = 15.0 min., SD = 7.9 min., n = 31) differed, but not significantly (Hamer and Nelson 1998). This nest fledged successfully. According to Tom Hamer (Aug 1, 2003, pers. comm.), this nest was not a typical murrelet nest for the Olympic Peninsula or the Mt. Baker Snoqualmie National Forest (MBS) for three reasons: (1) the adults chose to nest very close to a very busy highway; (2) the nest was situated only about 35-40 feet from the ground, whereas typical nests in the ONF and MBS are situated 75-100 feet from the ground; and (3) the murrelets used the open highway as their approach to the nest, clearing the pavement by only about 1 foot on their approach, and then flew up and "stalled" at the nest. The people walking within 40 meters of the nest described above were along the highway and were in the flight path of the approaching murrelets. In more typical settings, murrelets do not fly so low to the ground to approach nests so that pedestrians would be in their flight paths, and pedestrians typically would be obscured from view by vegetation (T. Hamer, Aug 1, 2003, pers. comm.).

At the North Rector nest, a ground observer who moved from being out of sight 35 meters away to the base of the nest tree caused a murrelet that was attempting to feed its chick to drop its fish and fly away; the same adult returned 1 hour 21 minutes later and fed the chick (Hamer and Nelson 1998). Of the 125 murrelet nests studied in an ongoing study in British Columbia (R. Bradley, Univ. BC, pers. comm.), the researchers have been able to access the base of only approximately 40 percent of the nest trees (or approximately 50 nests) due to difficult terrain, and have been able to observe the adult on the nest at about 10 percent of the nests (or approximately 12 nests). (They check nests for signs of success—fecal ring and down ring—after the estimated fledging date.) In all of these close approaches to nest trees, only once have they observed an adult flush from the nest; in that case, the biologist approached on foot within 20 yards of the nest in direct line of sight of the nest. Changing camera batteries 15-20 times per season has caused "disturbance" to chicks (apparently within about 1-2 m), but chicks became habituated to these people even when only 1 meter away (Long and Ralph 1998:16-17).

Researchers 3-10 meters from chicks caused three postponed feedings (in one case, the adult waited on the nest branch until the researcher climbed down the tree and then walked to the chick and fed it) and one feeding attempt that was either postponed or aborted (Long and Ralph 1998:16). A camera set up 1 meter from a chick caused "2-3" cases of postponed or aborted feeding attempts, but the adults resumed feeding after the camera was moved to 5 meters from the nest (Long and Ralph 1998:17). However, cameras placed at least 4 meters from chicks did not postpone or abort feeding attempts (Long and Ralph 1998:17). There are many cases in which nests fledged successfully after research activities near the nests, including chicks being handled every day for 9 and 20 days (Nelson and Hamer 1995:94).

Chicks appear to be much more difficult to disturb than adults. Chicks "did not seem to pay attention" or "looked toward the person" when researchers were within 6-35 meters (e.g., 6, 10, 20, 35 meters in Long and Ralph 1998:16).

Researchers may have contributed to failure of two nests (Brown pers. comm. and Binford et al. 1975 in Nelson and Hamer 1995), although Nelson and Hamer (1995) did not describe how these researchers did so. One of these nests was located on tree roots at ground level (Nelson and Hamer 1995). "In contrast [to these nests], intensive disturbance occurred at three successful nests. In Oregon, the only nest tree that was climbed while active was successful, and in Washington, chicks at two nests fledged despite regular climbing (approximately once a day for 9-20 days) to collect nestling growth and development data" (Nelson and Hamer 1995:94).

There are no documented instances of a nestling murrelet falling due to sound or visual disturbance, including disturbances due to researchers climbing nest trees, handling young, and placing cameras close to young.

Disturbances to Murrelets Due to Vehicles and Loud Noises

"Murrelets appeared generally undisturbed by passing vehicles...[or] sharp or prolonged loud noise" (Long and Ralph 1998:21). A murrelet study conducted in the Olympic National Park (Hall 2000) found no difference in average number of occupied detections or average number of all detections between developed sites and pristine sites (number of detections is a good metric for presence and occupancy, but is not a reliable indicator of effects of disturbance). Hamer (pers. comm. in Long and Ralph 1998) reported no reaction from a murrelet (the paper does not state if it was an adult or a chick) due to many rifle shots within 200 meters from the nest. An incubating adult "jumped, but did not abandon the nest" in response to a car door slamming within 150 meters of the nest (Nelson pers. comm. in Long and Ralph 1998). Long and Ralph (1998) reported very little responses by adults or chicks due to road-grading, logging operations within 0.5 mile, and loud radios. Murrelet chicks show little or no response to vehicles passing within 70 meters of the nest on lightly-used roads or heavily-used roads (Long and Ralph 1998). Typically, two large trucks needed to criss-cross in front of the Ruby Beach nest—the nest tree was located 8 meters from Hwy. 101—for the incubating adult to flush from the nest. The location of this nest indicates that the murrelets which chose to be so close to a busy highway were, apparently, relatively oblivious to vehicle traffic. The adult murrelets, when flying to this nest to feed the young, occasionally flew directly behind trucks, apparently using the trucks to "draft" during their nest-approach (K.

Nelson, Oregon State Univ., pers. comm.). Murrelets nest successfully in campgrounds with nests located directly above frequently-used picnic tables (K. Nelson, Oregon State Univ., pers. comm.). In Redwoods National Park, a murrelet chick was videotaped in 2001 for 1-1/2 hours while a person ran a chainsaw intermittently within approximately 40 meters of the nest tree. The chick dozed, preened, and stretched during the action, but showed no reaction to the noise or the people (P. Hebert, Cal. Dept. Fish and Game, pers. comm.). A man felled a tan oak with a chainsaw within 30 meters of an incubating adult murrelet, but the nest was successful; however, they could not determine whether the murrelet flushed (E. Burkett, Cal. Dept. Fish and Game, pers. comm.).

Disturbances to Murrelets Due to Aircraft

During the long-term study being conducted in British Columbia (R. Bradley, Univ. BC, 2002 pers. comm.), murrelets were captured at sea and fitted with radio transmitters. Once the marked birds were present on the water on alternate days, indicating that they were incubating an egg on the other days, Robinson 44 (four-seater) or 22 (two-seater) piston-engine helicopters were used to locate the incubating adults once per nest by low circling and hovering directly over the nest within 100-300 meters of the nest. This circling and hovering usually took about 3 minutes. None of the radio-tagged adults incubating any of the 125 nests located in this manner flushed (R. Bradley, Univ. BC, 2002, pers. comm.).

"Murrelets did not respond to either airplanes or helicopters flying overhead, except perhaps when they passed at low altitude" (Long and Ralph 1998:18). A chick had no response to an airplane passing twice within 0.25 mile at 1,000 ft, but another chick lay flat on the branch "when an aircraft passed at low altitudes" ("low altitudes" was not defined) (Long and Ralph 1998:18).

Disturbances to Murrelets Due to Pedestrians Near the Nest Not Due to Research

The following two instances were observed in Big Basin State Park (E. Burkett, Cal. Dept. Fish and Game, pers. comm.). In 1996, a radio-tagged male murrelet entered a stand of suitable habitat within a picnic area three mornings in a row during survey hours. He was only tracked the first morning, but was visually observed the second and third mornings. The second morning, he landed on a branch, stayed perched for some minutes, and then flew from the area. The third morning, he landed on a branch, and then some people arrived in a car, slammed the car doors, and talked loudly within 30 meters of the tree in which the murrelet was perched. The murrelet vocalized as if "agitated," and then he and his mate flew from limb to limb, and then they flew from the stand. The male was predated by a peregrine falcon (*Falco peregrinus*) later that day, so it is unknown if he would have returned to nest. The second instance also took place along a road. In this case, two perched murrelets flushed from a branch 10 meters from some pedestrians.

Adult murrelets in nest trees located 10 meters and 25 meters from heavily used hiking trails (and located 10 meters from a park sewage treatment plant and within a picnic area, respectively), and three nests overhanging a trail used by 25,000 visitors per year "rarely showed behavior suggesting agitation from human presence or noise" or showed "no visible reaction to loud talking [or] yelling...near the nest tree" (Singer 1991 in Long and Ralph 1998:17) (it is assumed that the bases of the nest-trees were 10 meters and 25 meters from the trails and treatment plant). Nests located directly over lightly used hiking trails (30 hikers/day) fledged successfully (Long and Ralph 1998:17). It was not stated in any of these studies how high off the ground these nests were situated.

Summary of Best-Available Information Concerning Disturbance of Spotted Owls

Spotted owls are well known for being naive, and frequently continue normal behaviors including mutual-preening, feeding, caching of prey, and sleeping within a few yards of observers. Few studies, however, have dealt with the effects of human disturbance on spotted owls. Fortunately, however, Delaney et al. (1999) tested the effects of helicopter noise and chainsaw use on nesting Mexican spotted owls (*Strix occidentalis lucida*) in New Mexico. In this study, Delaney et al. (1999:68) found that "during the non-nesting season, spotted owls did not flush from perches when the SEL [sound exposure level] noise level for helicopters was ≤104 dBO [owl-adjusted dB level] (92 dBA) and the LEQ [equivalent sound level] for chainsaws was ≤65 dBO (51 dBA). During the nesting season, spotted owls did not flush from perches when the SEL sound level for helicopters was ≤102 dBO (92 dBA) and the LEQ level for chainsaws was ≤59 dBO (46 dBA)." The 46 dB noise-level should not be viewed, however, as the sole cause of the flush. "Although chainsaws were ...operated out of sight, ... field crews had to set up recording equipment beneath the spotted owls... Subsequent chainsaw operations may have been associated more with this ground-based human activity" (Delaney et al. 1999:72). Their ambient sound-levels due to natural sounds were 25-40 dB. The owls returned to pre-disturbance behavior 10-15 minutes after the event. With their chainsaw tests, one of 21 tests (4.7%) at distances 75-105 meters caused a flush from a perch, whereas 7 of 23 tests (30.4%) caused flushes from perches at 60 meters. This one flush at 75-105 meters was at 105 meters which was also the farthest distance at which the spotted owls flushed due to helicopters. Their Table 3 (p. 67) presented the distances at which spotted owls flushed due to sights and sounds; when chainsaw tests were greater than 60 m from the spotted owls, there were no flushes during the non-nesting season, and during the nesting season, they had only one flush at distances greater than 60 m (at 105 m). They found a difference in flush response due to time of year: "All flushes recorded during the nesting season occurred after fledging; no flushes were elicited by manipulations during the incubation and nestling phases" (p. 67). They found no difference in reproductive success between manipulated and non-manipulated owls, but, due to the slight differences found, there were not enough nests in their study area to permit sufficient power to detect a significant difference. They stated (p. 67): "Overall, helicopters elicited 0 percent spotted owl response when beyond 105 m, 14 percent within 105 m, 19 percent within 60 m, and 50 percent within 30 m." They wrote that implementation of a 105-meter (350 foot) buffer zone for helicopter overflights on Lincoln National Forest would minimize flush responses of nesting Mexican spotted owls and any potential effects on nesting activities.

Delaney and Grubb (2001:13) referenced studies of ospreys (*Pandion haliaetus*) and spotted owls and stated: "In those studies that reported stimulus distance, it was rare for birds to flush when the stimulus was greater than 60 m..." They also stated (p. 13): "Snyder et al. (1978) reported that Snail Kites (*Rostrhamus sociabilis*) did not flush even when noise levels were up to 105 decibels, A-weighted (dBA) from commercial jet traffic. This result was qualified by the fact that the test birds were living near airports and may have habituated to the noise. Edwards et al. (1979) found a dose-response relationship for flush responses of several species of gallinaceous birds when approach distances were between 30 and 60 m and noise levels approximated 95 dBA." They noted that motorcycle noise levels at microphones placed 10 m above ground level in trees were louder and lost less noise energy over distance than microphones placed at the base of the same trees.

In Johnson and Reynolds (2002), Mexican spotted owls were observed during military fixed-wing aircraft training in which maximum noise levels measured at the owl site were 78, 92, and 95 dB for the three fly-bys, respectively. The overflights were approximately 460 m above the canyon rims. Behavior of the spotted owls ranged from no response to a sudden turning of the head.

Swarthout and Steidl (2001) studied flush responses of Mexican spotted owls in constricted canyons in the Utah desert in which hikers walked close to roosting spotted owls. They found that 95 percent of flushes by adult and juvenile spotted owls occurred within 24 m and 12 m, respectively, of the hikers, and that a 55-m buffer "would eliminate virtually all behavioral responses of owls to hikers" (p. 312). They noted that the spotted owls became sensitized to the hikers—that after spotted owls were flushed, the odds increased almost 7 times that they would flush on subsequent approaches.

Swarthout and Steidl (2003) analyzed how hikers walking past Mexican spotted owl nests affected the time that male and female spotted owls spent in various behaviors (active, alert, prey-handling, maintenance, incubating, resting) during 4-hour periods centered on sunrise (morning), midday, and sunset (evening). In response to hikers, females significantly decreased maintenance during midday and prey-handling behaviors during all time periods, and significantly increased the frequency of nest-attendance bouts and contact-calling during the evening period. The only changes in the males were that they made significantly more contact calls when hikers were present in the evening period, and they significantly delayed the start of vocalizations (by 24 minutes) when hikers were present during the morning period. The time that females and males spent attending the nest was not significantly affected by the hikers.

The following information concerning Swarthout and Steidl (2001 and 2003) was obtained during a phone conversation between K. Livezey of WWFWO and E. Swarthout on June 23, 2003. The hikers walked past the nests four times each hour for 4 hours, for a total of 16 passes. The disturbance effects in the papers were cumulative effects during all of the 15-min walking periods. The spotted owls nested in holes in the canyon walls. In their paper, they stated that the hikers walked "past" the nests, but they did not state how close. He told me that the nests were 11 to 68 meters directly above the hikers. The spotted owls did not have access to anywhere other than where the disturbance was; they did not fly up to the top of the canyon walls, because it was too hot up there. They had linear paths only, along the valley floor in the narrow riparian strip, and would be pushed up and down the canyon by the hikers. Their disturbance behavior could have been increased by their inability to escape the disturbance. In a forest, spotted owls can move in any direction, and can more easily escape. He agreed that the owls may have felt more hemmed-in in the canyons than they would in a forest. He said that, after capturing many spotted owls in forests in the Flagstaff area, how much more easily these owls flushed from the cliffs than the owls flushed in the forests near Flagstaff.

Harassment of Murrelets and Spotted Owls and Likelihood of Injury

Harassment is defined by 50 CFR §17.3 as "an intentional or negligent act or omission which creates the likelihood of injury by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, and sheltering." Such an act would create the likelihood that the animal in question would suffer reduced productivity or survival (e.g., lower fledging weight, physical injury or death of adult, hatchling, or egg) due to a sufficient number of aborted feedings or flushes.

During a FWS Project Leaders' meeting in the Portland Regional Office, February 22, 2002, the Project Leaders and biologists decided that behaviors indicating potential injury (harassment) to murrelets are: an adult flushing from the nest, aborting a feeding attempt, and postponing a feeding attempt if it cannot be determined whether the feeding attempt was aborted or merely postponed. At that meeting, we did not differentiate specifically between a postponed or an aborted feeding attempt. In the May, 2002, programmatic BO for projects to be conducted in ONF (USDI 2002), we defined "postponed" as a feeding that was still completed within the same morning or evening of the initial attempt. Herein, we modify this definition so that a postponed feeding for murrelets and spotted owls is one in which the adult successfully completes feeding its young with the same prey item. A postponed feeding is considered to be disturbance, not harassment.

Because our definition of injury includes only those behaviors which can take place during incubation and nestling periods (flushing from the nest and missed feeding), effects during those periods are pertinent to our analysis here. When murrelets fledge, they leave the area and fly to the ocean, so they are no longer of concern once they fledge. Recently fledged spotted owls, however, are dependent on feedings by their parents; therefore, we are including anticipated effects to juvenile spotted owls during the whole nesting period, including the first month after they fledge.

Introduction to the Thresholds

<u>The Sound Data Used Here</u>

The threshold analysis estimated here is a continuation of and refinement to the initial attempt to make such estimations for murrelets and spotted owls as presented in USDI

(2002b). Much of the sound-level analysis herein relies on dB data from a relatively old publication (Canter 1977). To make future analyses more current, the WWFWO recently acquired two sophisticated dB meters (Sokki Sound Level Meters Model LA-5111, Microphone No. 19353, Preamplifier No. 14247), and we anticipate gathering more current dB data for heavy equipment and, especially, for blasting during 2003 and 2004. It is expected that additional dB information and subsequent analyses will result in adjustments of some of the distances presented here.

For this BO, M. Hodgkins of WWFWO took dB readings of chainsaws on July 3, 2003, at the Hoodsport Office of ONF using the brand and sizes of chainsaws used on commercial timber sales in ONF (Stihl 34 and Stihl 38, both with 32-inch bars, circa 1998). The data are on file in the WWFWO. He took 1-minute readings, and the exhaust mufflers were pointed directly at the microphone, which was set on a sturdy tripod 50 feet from the chainsaws. The ground surface in between the chainsaw and the meter was grass and gravel. The min, max, and peak readings for the Stihl 34 chainsaw were 81.1, 84.2, and 97.5 dB, respectively, and min, max, and peak readings for the Stihl 38 chainsaw were 73.5, 90.8, and 104.2 dB, respectively. Canter (1977:134) reported 86 dB as the sound reading for a chainsaw, which is similar to our max readings. For our analysis here, we use the peak reading for the larger chainsaw (104 dB) because it more accurately represents the highest sound levels that could be expected from these chainsaws.

Differences Between the Thresholds

Not all human-caused sights or sounds are detected by murrelets and spotted owls; they may be too far from the sight or sound to detect it. Or, once detected, not all sights or sounds result in adverse effects. To help clarify this idea, one could consider that there are four distances, or thresholds, for sights and sounds that are above ambient levels: (1) the detectability threshold (where the sight or sound is detectable, but a murrelet or spotted owl has not shown any reaction); (2) the alert threshold (where a murrelet or spotted owl shows apparent interest in the sight or sound by orienting its head toward the action or extending its neck); (3) the disturbance threshold (where a murrelet or spotted owl shows apparent avoidance of the sight or sound by hiding, defending itself, moving its wings or body, or postponing a feeding so that the adult still feeds its young the same prey item); and (4) the injury threshold (where a murrelet or spotted owl is actually injured—here defined here as an adult flushing from the nest or a young missing a feeding).

The four categories just described were modified from Brown (1990), Awbrey and Bowles (1990), Delaney et al. (1999), and Swarthout and Steidl (2001). Brown (1990): (1) divided what is termed here as alert behavior into "scanning behaviour" (head-turning) and "alert behaviour" (e.g., fully extended neck, more tense body, take a few steps); (2) defined "startle/avoidance behaviour" as raising wings or flapping wings without flushing, which is the disturbance threshold here; and (3) defined "escape behaviour" as flight, which includes flushing and aborted/postponed feedings, which is the injury threshold here. Awbrey and Bowles (1990:Figure 2.4) assigned behaviors to the following categories: "none"; "alert" (bird raised its head or turned sharply to look at the stimulus); "respond" (bird reacted by moving (e.g., standing, crouching, calling, turning, walking a few steps) but did not flush from the nest; and "flight (flying from the nest). Delaney et al. (1999) defined "alert" (head movement), "react" (wing or body movements), and "flush" (taking to flight) behaviors. Swarthout and Steidl (2001) noted distances at which spotted owls became "alert" and shorter distances at which they "flushed."

Birds respond to sound and sight stimuli differently. Therefore, these threshold distances need to be determined separately. First, we estimated the sound-only threshold distances for detectability, alert, disturbance, and injury for murrelets and spotted owls. Then, we estimated the sight-only injury threshold distance and combined injury threshold distances for murrelets. Finally, we estimated the sight-only injury threshold distance and combined injury threshold distances for spotted owls. We made no attempt to estimate the sight-only thresholds for detectability, alert, or disturbance. The sight-only detectability threshold distance is completely dependent upon the eyesight of the bird, and whatever in the area of concern obscures or blocks visibility which could, at far distances, be due to the curvature of the earth. This distance threshold could be a few yards in some areas and miles in others. To determine this for a nesting murrelet or spotted owl would require tests of what their eyes are capable of seeing at various distances, and tests of visibility of stationary and moving objects from specific branches, at various distances, and at various ranges of vegetation and topography. To our knowledge, such an analysis has not been done.

<u>Detectability, Alert, Disturbance, and Injury Thresholds for Murrelets and Spotted Owls</u>

Process to Estimate Sound-only Thresholds for Murrelets and Spotted Owls

(1) We estimated that the *ambient* noise levels for the ONF were 40 dB. This value was based on the few ambient-level data available in the area, which are: 34.7-37.1 dB at Friday Harbor (San Juan Islands, L. Magnoni, WA Dept. of Transportation, pers. comm.), 42.5-43.9 dB within 200 meters of the South Fork of the Solduc River in the ONF in a 15-year old timber stand (S. Dilley, FWS, pers. comm.), and 35-57 dB in various locations in the Mt. Baker-Snoqualmie NF (Storm, MBS NF, pers. comm.). Ambient sound levels are expected to be different in various parts of the ONF, but this 40 dB level is estimated to be an average for relatively undisturbed areas. (The exact ambient dB level is not needed for the following presentation, so the approximate nature of these data is not important.)

(2) We estimated that the *sound-only detectability threshold* was 44 dB, which is 4 dB above the ambient level. Dooling and Hulse (1989) found that 16 species of birds showed an average sensitivity of 4 dB to detect a sound. In areas where the ambient or background sound levels differ from 40 dB, the detectability threshold would change accordingly.

(3) The *sound-only alert and disturbance thresholds* are between the detectability and injury thresholds, but we are unaware of any data that would allow us to estimate these directly with even the approximate precision as the other thresholds. Consequently, we subjectively and simplistically placed them between and equidistant from the detectability and injury thresholds and from each other. We think that it is important to include these thresholds, even though their precise dB levels are unknown, to help remind us that we do not expect that a bird would flush from a sound that is only a few dB louder than a sound that the bird is just barely able to detect.

(4) We estimated the *sound-only injury threshold* by using the only known data available for sound-only flushes. These data were from Thiessen and Shaw (1957), Awbrey and Bowles (1990), Brown (1990), and Delaney et al. (1999). Thiessen and Shaw (1957) found that caged ring-billed gulls (*Larus delawarensis*) subjected to sounds at a range of frequencies and decibel levels reacted by cringing at 83-91 dB at 150 cps (cycles per second = Hertz) and by increased heart rates at 92 dB; it is unknown at what dB level these birds would have flushed. Awbrey and Bowles (1990:21) stated that "what little published literature [on raptors] is available suggests that noise begins to disturb most birds at around 80-85 dB sound levels and that the threshold for the flight response is around 95 dB." Brown (1990) subjected crested terns to experimental noises imitating aircraft overflights in an area with 55-75 dB ambient noise levels, and found that, at 70 dB, about 55 percent were alert and, at 95 dB (the loudest they tested), approximately 15 percent were startled and 8 percent flushed. Delaney et al. (1999) found that Mexican spotted owls, during both the nesting season and the non-nesting season, did not flush from helicopter noise unless the noise was at least 92 dB(A). Due to results from all of these studies, we estimate the sound-only injury threshold to be 92-95 dB (rounded down to 92 dB). Unlike the ambient and background sound levels and detectability levels which are expected to differ somewhat throughout the ONF with its varying topography, weather conditions, etc., the sound-only injury thresholds presented here are expected to remain relatively constant.

(5) We produced a *sound attenuation figure* (Figure 1) by presenting the sound-only thresholds (as above) and the maximum sound attenuations for noise-generating activities. To produce the sound attenuations in this figure, we used the maximum sound levels reported in Canter (1977), and graphed approximate noise attenuation over distance for various noise-generating activities. Noise-levels typically are recorded at 50 feet from the noise-generating equipment. The reduction rate or attenuation of sound over distance is calculated by subtracting 7.5 dB(A) per doubling of distance for "soft sites" (e.g., vegetated areas). However, noise reductions result from certain atmospheric conditions, topography, and very dense vegetation; due to this, these reductions would, in the real world, be much less gradual than graphed here. Wind alone can reduce noise by as much as 20-30 dB at long distances (USDOT 1980). A break in the line of sight between the source and dB receptor can result in a 5 dB reduction, and dense vegetation can result in a 5 dB reduction for every 30 meters of dense vegetation, up to a maximum of 10 dB (USDOT 1980). The influences of these additional reducing factors are impossible to estimate due to their variability, and are not taken into account here.

Consequently, predictions of expected noise levels are expected to be higher on average than what would actually occur.

The maximum levels reported in Canter (1977) were: (1) piston helicopters (range 73-86 dB at 500 feet, or approximately 114 dB at 50 feet) and turbine helicopters (range 65-78 dB at 500 feet) (2-7 seats; Bell Jet Ranger or smaller) grouped with single-engine propeller airplanes (range 67-77 dB at approach at 1,000 feet or approximately 114 dB at 50 feet); (2) impact pile drivers (peak 106 dB); (3) jackhammers, rock drills (range 82-97 dB); (4) heavy equipment (range 72-96 dB); and (4) multi-engine propeller airplane (range 79-93 at takeoff). For chainsaws, we used the peak reading (104 dB) taken in our effort as described above. Due to the concussive nature of jackhammers and rock drills, we placed those activities with impact pile drivers.

We graphed the dB levels by: (1) taking the dB level from Canter (1977) at 50 ft (approximated to 15 yards here); (2) 7.5 dB was subtracted from each of these initial readings with the doubling of distance (at 30 yards, 60 yards, 120 yards, 240 yards, and 480 yards) following US DOT (1980); (3) intervening values at 15-yard intervals were approximated to generate smooth curves; and (4) the results were graphed for the range of 0 to 480 yards. The curves in Figure 1 are not as smooth as they would be if the data had been generated directly from the sound-attenuation equation, but the overall shapes were kept in check by the actual doubling-of-distance figures. So we estimated these sound-only levels to be: 40 dB for the ambient sound level; 44 dB for the detect threshold; 57 dB for the alert threshold; 70 dB for the disturbance threshold; and 92 for the injury threshold.

We do not have dB data for large helicopters (such as Sikorsky-type helicopters used for logging) on which to determine thresholds for these activities. In addition, we do not have sufficient information to place blasts of different sizes and locations into injury-distance categories, due to variables including differences in loudness of blasting materials, methods used to place blasts (e.g., above ground, below ground), and topography around blast sites. Therefore, we consider the injury distance for all blasts to be 1 mile, unless method-specific and/or site-specific information indicates shorter or longer distances. Analysis of such information should be addressed by the Level 1 Team.

From Figure 1 (and its associated spreadsheet), the distances at which the sound-only injury thresholds were reached for murrelets and spotted owls were:

- for an impact pile driver, a jackhammer, or a rock drill—60 yards
- for a helicopter or a single-engine airplane—120 yards
- for chainsaws—45 yards
- for heavy equipment—25 yards

Process to Estimate Sight-only Injury Thresholds for Murrelets

We estimated the sight-only injury threshold—the distance at which a murrelet would be flushed from its nest or cause it to miss feeding one of its young by the sight (not sight *and* sound) of human activity—using the incidental and experimental experiences of murrelet researchers as described above. Overall, the farthest murrelets flushed from perches or nests due to the presence of thousands of pedestrians (without motorized equipment) was 10 meters (11 yards), other than the unusually situated nest at Ruby Beach (see "Disturbances to Murrelets Due to Researchers" and "Disturbances to Murrelets Due to Vehicles and Loud Noises" above). So the sight-only injury threshold distance for murrelets is 11 yards.

Process to Estimate Combined Injury Thresholds for Murrelets

(1) The longer distance for each of the thresholds, using the distances for the sound-only injury thresholds and the sight-only injury thresholds, was used as a minimum for the combined injury thresholds. In every case, the sound-only injury distances were longer than the sight-only injury distances, so we kept the sound-only distances as the combined injury threshold distances.

(2) The combined injury thresholds correspond to more typical occurrences—activities that are both seen and heard. We anticipate that there is a synergistic effect between such activities, and that murrelets could react to such activities at farther distances than those merely heard or seen. We also anticipate that many activities could be both seen and heard by murrelets at the relatively short sight-only and sound-only injury thresholds proposed here. The observation of the radio-tagged male murrelet and his mate that flushed from a suitable-habitat stand due to people slamming car doors and talking loudly within 30 meters (32.8 yards) of the tree in which one of the murrelets was perched (E. Burkett, Cal. Dept. Fish and Game, pers. comm.) is our farthest-distance example of such an occurrence. This activity was similar to the use of heavy equipment. To accommodate this observation, we extended the combined injury threshold for heavy equipment for murrelets to 35 yards (rounded up from 32.8 yards).

(3) We know of no literature to indicate that the sight of a falling tree due to chainsaw work would cause harassment to murrelets farther away than the sound-only injury threshold of 45 yards. Consequently, we did not extend this distance for timber-harvest activities. If a tree is felled and then limbed, the final, combined injury distance would be calculated not only from where the tree was felled, but also from where it was limbed.

(4) The best-available information we have concerning effects to murrelets from helicopters is from the long-term study conducted in British Columbia (R. Bradley, Univ. BC, 2002 pers. comm.). Due to the high-nesting behavior of murrelets, we anticipate that many of the murrelets could see these helicopters, and may have been able to feel the downwash of the helicopter blades. In this BC study, they had no flushes from nests when the helicopters circled and hovered directly over the nest within 100-300 meters of the nest ($n = 125$), so we do not know at what distance murrelets would flush from helicopters. We view our 120-yard (110-meter) harassment distance for helicopters estimated using 92dB as the sound-only criterion, therefore, as conservative.

(5) The combined injury thresholds for murrelets and spotted owls are presented at the end of the spotted owl section below.

Conservative Distance Estimates for Murrelets

We chose to be conservative in assuming that these activities could injure murrelets at all. We have no data showing that human-caused activities described in the Project Descriptions have caused injury of murrelets, and there are many cases of close encounters with humans, trucks, and helicopters that did not cause the birds to flush from the nest. The data we have indicate that the most disturbing human activity is researchers climbing murrelet nest trees. Especially, we do not have any data showing injury of murrelets due to sound alone, with no visual cues.

Likelihood of Injury to Murrelets

Because we do not have adequate data relative to the numbers of murrelets or their distribution in ONF, we use their habitat as their surrogate, and assume equal distribution of these projects throughout suitable, occupied habitat. To estimate the likelihood of injury, we estimate the number of presumed occupied, suitable acres within the injury distances in which we anticipate that injury would occur. However, we do not assume that all of the area within each activity-site is equally likely to be disturbed or injured (harassed). We do not have sufficient data to accurately quantify the disturbance-related injury that is "reasonably certain to occur" or what is "likely to occur," but here we provide a general description of how much of this injury we are attempting to include in these injury distances. We anticipate that high percentages of murrelets at very close distances to these actions could be injured, and that the percentage of affected murrelets would decrease with increasing distance so that, at the far ends of the injury thresholds for each action, a very small percentage of the murrelets could be injured as a result of the disturbance. Consequently, we do not anticipate that all murrelets within these injury distances would be injured. We anticipate that this attenuation of effects probably drops for some distance and then levels off, similar to the attenuation of sounds over distance, but this is unknown and expected to differ by many factors including type of disturbance, loudness of sounds, topography, and experience of the murrelets in question concerning these disturbances.

It is possible that adverse effects due to people (non-researchers) in murrelet habitat not using motorized equipment (e.g., hikers, hunters) could occur, but here we need to estimate if any injury due to people not using motorized equipment is reasonably certain to occur. In such an analysis, habituation (decrease of disturbance behavior over time) and sensitization (increase of disturbance behavior over time) of murrelets to human presence is of issue. As stated in Long and Ralph (1998:15), "It should be noted that previous exposure to people may influence the reaction of murrelets to disturbances." Murrelets can become either habituated to nearby activity, such as adults becoming used to hikers on trails or chicks becoming used to researchers changing batteries in cameras, or they can become sensitized to activity, such as adults that flushed from nests after researchers had climbed the nest tree and then closely approached the nest (Long and Ralph 1998). The most-probable examples of disturbance-related injury of murrelets from the literature are from researchers that closely approached nests, and from subsequent visits to the nest after, probably, the adults had been sensitized. It may be that to injure murrelets, they need to feel that they are physically threatened by the presence of a possible predator very close to the nest. If so, then only those nesting birds which have been very closely approached—subjects of increased sensitivity to human disturbance—would likely be injured. Because such close approach only occurs due to research, it may be that disturbance-related injury is most likely from research and from activities with visual clues that are very close to nest trees and when the adults of those specific nests have been sensitized. Consequently, people in murrelet habitat who are not using motorized equipment (other than researchers who climb the nest tree) or blasting are not considered here to be likely to result in disturbance-related injury.

Process to Estimate Sight-only Injury Thresholds for Spotted Owls

We estimated the sight-only injury threshold—the distance at which a spotted owl would be flushed from its nest or cause it to miss feeding one of its young by the sight (not sight *and* sound) of human activity using two types of sources. First, we used experiences by northern spotted owl biologists (pers. comm. from: (1) T. Fleming, Nat. Council for Air and Stream Improvement, Brush Prairie, WA; (2) E. Forsman, U.S. Forest Service, Corvallis, OR; (3) D. Herter, Raedeke Assoc., Seattle, WA; (4) R. Pearson, owl surveyor, Packwood, WA; (5) J. Reid, Bureau of Land Mgmt., Roseburg, OR; and (6) D. Rock, Nat. Council for Air and Stream Improvement, Amboy, OR) expressly for this BO. These biologists stated that: spotted owls rarely flush due to disturbance from people; when a spotted owl is sitting on a perch, the person would likely need to be within 2-6 yards to flush it; when a spotted owl is sitting on its open nest, the person would need to climb the nest tree; and when a spotted owl is sitting in its cavity nest, the person would need to look into the nest hole. Second, we used results from the Mexican spotted owls study by Swarthout and Steidl (2001) who found that 95 percent of flushes by adult and juvenile spotted owls occurred within 24 m and 12 m, respectively, of the hikers, and that a 55-m buffer "would eliminate virtually all behavioral responses of owls to hikers" (p. 312). Their 55-meter distance would include not only our injury threshold, but our alert and disturbance thresholds as well. The 12- and 24-meter distances correspond to our injury thresholds for juvenile and adult spotted owls. Rather than set the sight-only injury distance at 6 yards, we anticipate that some spotted owls could act more like the Mexican spotted owls, so we conservatively compromised between 6 yards and 26 yards and set the sight-only injury threshold at 20 yards.

Process to Estimate Combined Injury Thresholds for Spotted Owls

(1) The longer distance for each of the thresholds, using the distances for the sound-only injury thresholds and the sight-only injury thresholds, was used as a minimum for the combined injury thresholds. In every case, the sound-only injury distances were longer than the sight-only injury distances.

(2) The combined injury thresholds correspond to more typical occurrences—activities that are both seen and heard. We anticipate that there is a synergistic effect between such activities, and that spotted owls could react to such activities at farther distances than those merely heard or seen. We also anticipate that many activities could be both seen and heard by spotted owls at the relatively short sight-only and sound-only injury thresholds proposed here. The study by Delaney et al. (1999) includes the most pertinent results concerning reactions of spotted owls to ground-based, mechanized activities that could be both seen and heard by the spotted owls.

(3) As stated above, behaviors indicating potential injury (harassment) to spotted owls are: flushing from the nest, aborted feeding, and postponed feeding. For spotted owls, the peer-reviewed research data presented here (i.e., Delaney et al. 1999, Swarthout and Steidl 2001) concerned flushing spotted owls from perches—not from nests. We have no data to indicate that spotted owls flush from the nest or abort feedings due to disturbances at farther distances than the sound-only injury threshold distances presented here, and the spotted owls studied by Delaney et al. (1999) never flushed during the incubation and nestling phases in the chainsaw and helicopter tests. Those findings would indicate that we need not increase the sound-only injury distances presented above to produce longer combined injury threshold distances. However, Delaney et al. (1999) did observe relatively frequent flushes from branches up to 60 meters from the disturbance during the later part of the nesting period. The one flush from farther than 60 meters (at 105 meters) observed by Delaney et al. (1999) was an unusual event; only 4.8% (1 of 21) of their chainsaw trials greater than 60 meters and less than 105 meters from the spotted owls resulted in a flush, whereas 30.4% (7 of 23) of their chainsaw trials at 60 meters resulted in a flush. We consider flushes farther than 60 meters to be unlikely events, so we did not increase the chainsaw injury threshold beyond 60 meters. As stated above, we are concerned that an adult spotted owl flushing from a branch when the juveniles are no more than 1 month of age could result in a missed feeding. So, to include the observations of Delaney et al. (1999) concerning flushes during the later part of the nesting season, the combined injury threshold for chainsaws is increased to 65 yards (60 meters). We assumed that the effects due to heavy equipment would be similar to those of chainsaws (even though heavy equipment is quieter than chainsaws), so we increased the harassment distance for heavy equipment in the same proportion as we did for chainsaws, resulting in 35 yards for heavy equipment for spotted owls. (That is, 45 yards X 1.44 = 65 yards for chainsaws, and 25 yards X 1.40 = 35 yards for heavy equipment.)

(4) We know of no literature to indicate that the sight of a falling tree due to chainsaw work would cause harassment to spotted owls farther away than 65 yards. Consequently, we did not extend this distance for timber-harvest activities. If a tree is felled and then limbed, the final, combined injury distance would be calculated not only from where the tree was felled, but also from where it was limbed.

(5) The spotted owls apparently did not see the helicopters used in Delaney et al. (1999), so those results are pertinent to our sound-only threshold distances. The 120-yard (110-meter) harassment distance for helicopters estimated in our analysis here using 92dB as the sound-only criterion is 5 meters farther than the distance at which Delaney et al.

(1999) reported *any* responses by spotted owls, so we view this helicopter-harassment distance as conservative.

Likelihood of Injury to Spotted Owls

The likelihood of injury was presented above in the murrelet section of that title; we anticipate similar effects to spotted owls. It is possible that adverse effects due to people (non-researchers) in spotted owl habitat not using motorized equipment (e.g., hikers, hunters) could occur, but here we need to estimate if injury due to people not using motorized equipment is reasonably certain to occur. In such an analysis, naiveté, habituation, and sensitization of spotted owls to human presence are of issue. Spotted owls are well known for being naive, and frequently continue normal behaviors including mutual-preening, feeding, caching of prey, and sleeping within a few yards of observers. The protocol to find spotted owl nests and to determine whether young are present is to feed mice to adult spotted owls and watch to see whether they go to their nests, or feed their mates or young ("mousing") (USDA and USDI 1999). The spotted owl biologists listed in "Process to Estimate Sight-only Injury Thresholds for Spotted Owls" agree that surveying for spotted owls by hooting, mousing, and by marking is more disruptive to spotted owls than any of the mechanized projects covered in this BO, and that there are many spotted owl pairs nesting successfully only 50-100 yards from active roads. The differences between the setting in the Utah desert in which the Mexican spotted owls studied by Swarthout and Steidl (2001, 2003) and ONF were described above, and are here used in support of not estimating harassment for spotted owls due to pedestrians for ONF. For the above-stated reasons, people in spotted owl habitat who are not using motorized equipment (other than researchers who climb the nest tree) or blasting are not considered here to be likely to result in disturbance-related injury.

Summary of Process to Estimate Injury Thresholds for Murrelets and Spotted Owls

(1) Noises as low as of 92-95 dB can cause birds of all tested taxa to flush, so we set the sound-only injury threshold at 92 dB. Using a typical sound attenuation graph, we set the sound-only injury distances for these activities.

(2) We did not have dB data to allow us to place various sized blasts into the sound attenuation graph.

(3) For murrelets, we set the sight-only injury distance at 11 yards, which was the farthest distance of flushing due to pedestrians (without other noises) from incidental accounts. For spotted owls, we set the sight-only injury distance at 20 yards, which was a compromise between 2-6 yards as reported to us by northern spotted owl biologists, and 26 yards in a Mexican spotted owl study.

(4) In every case, the sound-only injury distances were either longer than or equal to the sight-only injury distances.

(5) For the final, combined injury threshold distances for murrelets, we increased the sound-only distance of 25 yards for heavy equipment to 35 yards to accommodate the reported instance of a pair of murrelets that left a suitable-habitat stand (one of which flushed from a branch) due to people slamming car doors and talking loudly within 30 meters (32.8 yards) of the tree in which the murrelet was perched.

(6) For the final, combined injury threshold distances for spotted owls, we used data concerning flushing of adults from perches during the late nesting season due to chainsaws to lengthen that distance to 65 yards. We assumed that the effects due to heavy equipment would be relatively similar to those of chainsaws (even though heavy equipment is quieter than chainsaws), so we increased the harassment distance for heavy equipment in the same proportion as we had done for the chainsaws, resulting in 35 yards for heavy equipment for spotted owls.

(7) Our combined injury threshold distances are in agreement with published literature and anecdotal accounts of harassment of murrelets and spotted owls, other than our injury threshold distances for helicopters, which we view as conservative.

(8) The combined injury threshold distances for murrelets and spotted owls are presented in the following table. The only differences between the species are in the chainsaw distances.

Activity	**Combined injury threshold distances: murrelet / spotted owl**
a blast, a large helicopter, a large airplane	1 mile* / 1 mile*
a small helicopter or a single-engine airplane	120 yards / 120 yards
an impact pile driver, a jackhammer, or a rock drill	60 yards / 60 yards
chainsaws (firewood cutting, hazard trees, pre-commercial thinning, and commercial thinning)	45 yards / 65 yards
heavy equipment	35 yards / 35 yards

* Site-, equipment-, and method-specific information can be used to shorten or lengthen the 1-mile distance for these activities.

(9) We recently acquired two sophisticated dB meters, and we anticipate gathering more current dB data for heavy equipment and, especially, for blasting during 2003 and 2004. It is expected that additional dB information and subsequent analyses will result in adjustments of some of these distances.

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Figure 1. Calculated sound attenuation of maximum dB levels of noise-generating actions in a vegetated area and estimated sound-only detectability, alert, disturbance, and injury thresholds